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AD 838283

TRANSLATION NO. 515

DATE: 15 July 1968

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AUG 21 1968

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DEPARTMENT OF THE ARMY  
Fort Detrick  
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UNITED STATES ARMY  
CHEMICAL CORPS BIOLOGICAL LABORATORIES  
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*Plague*  
Some Epidemiological and Clinical Peculiarities of Plague in Its  
Natural Nidi in the Territory of Bayan Hongor Aymak of the Mongolian  
People's Republic.

by G. V. Bulanova

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Translated from Izvestiya Irkutskogo Gosudarstvennogo Nauchno-Issledovatel'skogo Protivochumnogo Instituta Sibiri i Dal'nego Vostoka (Reports of the Irkutsk State Scientific-Research Antiplague Institute of Siberia and the Far East), 20: 77-85, 1959, by SFC E. E. Ewing, Technical Library, Technical Information Division.

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The Central Asiatic Plateau, a portion of which is comprised by the Mongolian People's Republic, is considered an ancient epidemic nidus of plague, where its main vector is the tarbagan. The causes of the epidemicity of this nidus, as is well known, was established by D. K. Zabolotnyy in 1911 after he obtained a plague culture from a diseased tarbagan that had been caught.

Plague has been registered almost every year for many years in the different regions of Mongolia, but the most unfortunate in this respect has been Bayan Hongor Aymak (Aymak - Administrative-territorial unit - Tr. note), which is situated in the central part of Mongolia, in the foothills of the Southern Hangayn.

The topography of the region is mountainous, heavily broken, and in places reaching 3,000-4,000 meters above sea level. The earth surface is covered by small pebbles and rubble, particularly in the southern part of the aymak. The climate is severe and acutely continental. The air temperature is unstable.

Large fluctuations of the daily temperature are noted, particularly in the spring and fall. The day-time heat is replaced by night frosts. In the winter, the temperature drops to 50°-60°C below zero. The snow cover is relatively small. Winds are very frequent.

The hydrography of the subject aymak is represented by small lakes and intermittent mountain rivers that are filled in the thaw season, or during heavy rains. The basic mass of precipitations occurs in the summer.

The plant world is represented by the type of wormwood grasses of the highland steppes, with a sparse grassiness. In the northern part of the aymak, one encounters a brushy vegetation, and on the northern slopes of the mountains - coniferous forests. In the south, the vegetation is sparse. The blossoming of the vegetation begins from the middle of June, after sufficient moistening and warming of the soil. The wilting occurs from the middle of August, and by the end of September, the steppes take on a dismal, monotonous yellowish brown tone.

The animal world is rich and varied. Large numbers of birds are found. The order of rodents is particularly well represented: tarbagans, long-tailed susliks (pocket gophers), Mongolian pikas, Brandt's field mice, mole-rats, hamsters, house mice, rabbits.

The tarbagan has an universal spread. Its density approaches 200 specimens per square kilometer, with a greater density in the northern parts of the region.

The long-tailed suslik is another numerous species. It inhabits the same places as the tarbagan and comes in close contact with it. Its density also reaches 200 specimens per square kilometer.

The Mongolian pika is spread throughout the southern part of the aymak, in the rocky region. The density is 40 rodents per square kilometer. The pika is closely associated with the tarbagans and the susliks, often inhabiting the susliks' empty burrows.

Brandt's field mouse is encountered over the entire area of Bayan Hongor Aymak and has a mosaic pattern of population. In its areas of settlement, it is in close contact with the tarbagans and susliks.

The territory of Bayan Hongor Aymak has been considered an active nidus of plague since 1942, whereupon the activity of the nidus has been heightened considerably during recent times. Beginning with 1942, there has been registration of epizootics among the rodents and illnesses among humans here every year. In 1953, our detachment, which was operating in Bayan Hongor Aymak from the base of the Zakovskiy Antiplague Station, registered 10 epizootics at 8 points. The epizootics began in early spring and lasted until the rodents went into hibernation. Moreover, in 1953, there were many new epizootic points registered in places that were previously safe.

There were 2,169 rodents investigated during the work of our detachment. Of these, 875 were tarbagans, which were procured by collecting the dead rodents during early morning inspections, by shooting live rodents, primarily the sluggish tarbagans, and also by trapping.

It should be noted that the most effective method of obtaining the rodents in our work, was the collection of the deceased rodents. Thus, from the 875 tarbagans that were bacteriologically examined, there were 20 cultures of the plague microbe obtained; whereupon there were 16 cultures isolated from 36 of the deceased, which comprises 44.4%. There were no plague cultures isolated from the other species of rodents.

There were two plague cultures obtained from 1,541 fleas collected from the tarbagans and long-tailed susliks. Moreover, these cultures were isolated from fleas taken from tarbagans.

The density index of the fleas on the rodents was 0.3. An examination of the burrows detected an insignificant quantity of ectoparasites.

There was not a single plague culture isolated from the 855 ticks taken from the Mongolian pikas.

As a consequence of the epizootological situation that was created in the subject aymak, there were human plague cases in 5 nidi, which developed independently. The illnesses were of a professional character for the most part. The first to become ill in a nidus were the tarbagan hunters or members of their immediate family. There was a total of 9 illnesses registered, of which 4 was primary pulmonary plague; 2 - bubonic; 2 - intestinal and 1 - cutaneous-bubonic.

The first plague cases began from July and the last case was in October, 1953. Presuming that plague cases with such a variety of clinical forms represent considerable interest, we deem it necessary to delve into each individual nidus in more detail.

Nidus No. 1. On 14 July, a four year old child became ill in the village. The illness began suddenly. Chills, violent headache, pain in the stomach, vomiting diarrhea, temperature 40.5°C. The child's condition worsened rapidly and a few hours prior to the child's death, it began to cough up sputum "dotted with red spots" (in the words of the parents). The detachment, which arrived 15 July, detected the following during the examination: The body was in a nomad's tent (where the child died); he lay on bedding soiled with liquidly bloody feces and vomitus.

An autopsy of the child's body showed the following pathologic-anatomy picture: the body of a child of correct body configuration that had suffered an acutely decreased diet. There are no external skin damages detected. There are cyanotic blotches distributed over the entire surface of the body. The axillary, inguinal and submaxillary lymph nodes are unenlarged. The oral mucosa is cyanotic. A bloody fluid is found in the oral cavity. The vessels of the subcutaneous cellular tissue are acutely injected. There is a small amount of bloody exudate in the chest cavity. The lungs are enlarged, of a cyanotic rose color; a frothy bloody fluid flows from the surface of the incision. The myocardium is flaccid, grayish in color, with a great number of punctate hemorrhages. The liver is enlarged, the sections of a yellowish color in the incision. The spleen is acutely enlarged, cyanotic, the capsule turgid. In the incision the spleen is cherry red with a large scraping of pulp. The omentum and mesentery of the small intestine are acutely hyperemic. The mesenteric lymph nodes are multiple, juicy, hyperemic and enlarged (some of them as large as a bean). The mucosa of the small intestine is edematous and hyperemic. There is a large amount of fluid and bloody fecal masses in the intestine.

Based on the epidemiological anamnesis (13 July - consumption of meat of a tarbagan that had been brought to the tent by a dog) and also on the pathologic-anatomy findings, we established the diagnosis as a primary-intestinal form of plague with a subsequent sepsis. This diagnosis was also confirmed bacterioscopically, bacteriologically and biologically. Gram-negative bipolar bacilli were detected in the smear impressions from all of the organs. A growth of a pure culture of the plague pathogen was obtained on agar plates from the spleen, liver, mesenteric lymph nodes and lungs. An inoculated guinea pig died on the fourth day with a positive bacterioscopy and a subsequent isolation of a pure culture of the plague microbe.

The next patients in the given nidus were the deceased child's parents, who were isolated, but not subjected to prophylactic treatment. On 18 July, on the third day of isolation, they were afflicted by an illness typical of the primary-pulmonary form of plague. A diagnosis was made on the basis of the clinical picture (chill, rapid rise in temperature, pain in the chest, serious condition, coughing with a large amount of bloody sputum) and on the laboratory findings (bacterioscopy, growth of a plague culture on agar, positive test with the plague phage, typical growth in broth). Treatment with streptomycin, sulfidine and methylene blue (antiplague serum was not used) was begun after the patients' temperatures began to rise. After the treatment had been conducted for 27 days, they were released from the hospital in good condition. After 4 months, during one of their visits, it was noted that not only were both of the convalescents in good condition, but also that the woman was 6-7 months pregnant. The illness with the primary pulmonary plague had not reflected on the course of the pregnancy (during the illness, she had been 2-3 months pregnant).

Nidus No. 2. On 16 July at 10 P.M., the detachment, upon call, departed for a village located 40 kilometers from the place of the first outbreak. Arriving at the spot, it was discovered that the patient, a 40 year old man, was not a tarbagan hunter and had had no contact whatsoever with tarbagans recently. He worked cattle on the steppe. The following was learned from the anamnesis: on 13 July, a cyanotic-red, violently pruritic spot had been discovered on the patient's right side above the inguinal fold. Immediately, there appeared a slight tumescence of the inguinal lymph node, which very rapidly increased in size. A great painfulness was noted. Simultaneously, there appeared a chill and headache, and the temperature rose. The patient was in a grave condition. What attracted the attention was the strained position (the right leg contracted) and the suffering expression of the face.

At the time of the examination, the patient complained of a violent headache, a pain in the groin and in the chest, a slight dry cough was noted (without sputum). On the right side, above the inguinal fold, we discovered a cyanotic-red spot the size of a kopeck coin, a groin bubo the size of an egg that is adherent to the contiguous tissues and acutely painful during palpation, temperature 40°C, pulse rapid, weak (threadlike). A hemorrhagic specimen was drawn off by a puncture of the bubo.

The epidemiological data (location in the steppe, and, possibly, a bite from an infected flea), the clinical picture of the disease and also a

positive bacterioscopy allowed us to make a preliminary diagnosis of a cutaneous bubonic form of plague.

Treatment with streptomycin and sulfidine and the use of cardiotonics did not improve the condition of the patient's health, and on the morning of the following day, 17 July, he died. For a few hours prior to his death, there was a cough with a slight content of bloody sputum.

An autopsy of the body gave the following pathologic-anatomy picture: the body of a man of proper body configuration that had suffered a decreased diet. On the skin above the right inguinal fold is a cyanotic-red, slightly raised spot, the right lymph node is enlarged. In cross section the tissues contiguous to the area of the skin where the spot is situated are acutely hyperemic and edematous; in the subcutaneous fat tissue there is a thick strand stretching down from the spot to the regional lymph node. The tissues around the right inguinal lymph node are edematous and shot through with blood. The subcutaneous fat layer of the abdomen is hyperemic and edematous. There is a small amount of sanguinolent exudate in the pleural cavity. The lungs are enlarged, of a cyanotic rose color. A large amount of frothy bloody fluid flows from the surface of the incision. The myocardium is flaccid; in the cross section, it appears as cooked meat. There is a sanguinolent fluid in the pericardiac cavity; the spleen is acutely enlarged. The capsule is turgid and, in cross section, has a dark cherry color, with a large scraping of pulp. The liver is enlarged; spots of a dark orange color are noted on its surface.

The findings from the pathologic-anatomy dissection and also the laboratory investigation of the body's organs allowed us to conclusively establish the diagnosis as cutaneous-bubonic plague complicated by a secondary pulmonary pneumonia.

There were no other cases in this nidus.

Nidus No. 3. On 22 August, the detachment was called to Bayan Bulak Somon, over 190 km from the Zakovskiy Antiplague Station, where it arrived at 2 A.M. The patient was in an extremely grave condition. There was a frequent coughing, with a profuse bloody sputum. The breathing was bubbly and fast; the pulse threadlike and uncountable, temperature 41° C. A large number of huge vesicular moist rales in the lungs, a thudding sound of the heart, arrhythmia. The patient was given streptomycin, camphor and sulfidine. In spite of this the patient died soon after the arrival of the detachment. A preliminary diagnosis of primary pulmonary plague was made on the basis of the clinical data.

The following was discovered during the epidemiological investigation: the 18 year old son of the deceased had hunted for tarbagans. On 11-13 August, he discovered a sluggish tarbagan, which he killed with a rock. The carcass was cut up and used for food. On 15 August (on the second day after the consumption of the meat), the son had a chill, a violent headache, a pain in the stomach and frequent diarrhea and vomiting. The condition worsened acutely. On the third day, the patient had a cough with bloody sputum, and by evening he died. The body was left in the mountains and the family rode 15 kilometers away, according to the Mongolian custom. On the second day after this, the

father, who had cared for the son, began to feel a general indisposition. On the return of the oldest son from the aymak's center, the family again quickly rode 15-20 kilometers away to a new place. The patient's condition worsened; soon, the cough with the bloody sputum appeared.

The oldest son, evidently having a knowledge of plague, reported what had occurred to the antiplague station; at his call, our detachment arrived to find the patient in agony.

After the father's death, the family was placed in isolation. A guard was sent to the site of the old camp (where the son had died). On 23 August, there was a pathologic-anatomy dissection made on the father's body. The deceased was of proper body configuration, and had suffered a decreased diet. The skin is covered with multiple cyanotic blotches. The axillary and inguinal lymph nodes are unenlarged. There is no exterior signs of damage to the skin. A sanguinolent fluid is discharged from the mouth and nasal cavity. The vessels of the subcutaneous cellular tissue are acutely injected. There is a large amount of hemorrhagic exudate in the chest cavity. The lungs are acutely hyperemic. There is a large amount of a frothy sanguinolent fluid in the incision. The myocardium is flaccid, of a grayish color. There are punctate hemorrhages on the myocardium. There is a sanguinolent exudate in the pericardiac cavity. The spleen is enlarged, in the cross section, it is a dark cherry color, with a large scraping of pulp. The liver is enlarged, with yellowish-orange spots on the surface. The data from the epidemiological analysis, the clinical and also the pathologic-anatomy pictures, and the positive bacterioscopy, all enabled us to establish a preliminary diagnosis of primary pulmonary plague.

After precautionary measures had been taken (cremation of the body, detection of contacts), a laboratory worker was left to watch over those in isolation, and the detachment departed for the old camp site where the body of the first victim was located. There the body was subjected to autopsy.

The body of a youth who had suffered a decreased diet, immature (possibly no more than 13 years of age). The skin is pale with cadaverous blotches. The inguinal and axillary lymph nodes are not palpable. The cutaneous covering was undamaged. The vessels of the subcutaneous cellular tissue are injected. There is a small amount of hemorrhagic exudate in the chest cavity. The lungs are of a cyanotic rose color. On incision of the surface, a frothy sanguinolent fluid flows out. The spleen is acutely enlarged, of a dark cherry color in the incision, with a large scraping of pulp. The liver is enlarged, with sections of a yellowish-orange color.

The mesenteric vessels of the small intestine are acutely injected. The mesenteric lymph nodes are enlarged, juicy and hyperemic. Individual lymph nodes are as large as a large kidney bean or regular bean. The mucosa of the small intestine is acutely hyperemic. The intestine is filled with a sanguinolent content.

On the basis of the pathologic-anatomy dissection, a preliminary diagnosis was made as follows: primary intestinal plague complicated by a secondary plague pneumonia.



The plague diagnosis, both for the youth and the father, was confirmed by bacteriological, bacterioscopic and biological methods.

On 27 August, on the 5th day of isolation, the oldest son became ill. He had chills, headache and temperature. Several hours after the temperature rise, he began coughing up bloody sputum. Treatment of the patient with streptomycin, sulfidine and methylene blue (without antiplague serum) was begun. After the course of treatment, the patient was released on the 30th day in good condition.

A diagnosis of primary pulmonary plague was made on the basis of the clinical data and confirmed bacterioscopically, bacteriologically and biologically.

Nidus No. 4. On 3 September, the detachment, in answer to a call, drove to settlement Y. The patient proved to be a 12 year old boy. The detachment found him in grave condition. Temperature 41°C. The pulse thready, uncountable. Breathing rapid. During the auscultation of the organs of the chest cage, there was a great number of huge vesicular moist rales, thudding sounds of the heart, arrhythmia.

During palpation, an acutely painful lymph node, the size of a walnut, and adherent to the surrounding tissues, was found in the right axillary region.

The clinical diagnosis: bubonic plague complicated by plague pneumonia. Treatment of the patient with streptomycin and sulfidine was begun, and cardiotonics were used.

In the epidemiological investigation of the case, the following was discovered: six days prior, the boy had arrived from the settlement of Yamat, situated 40 kilometers from his home. (We had discovered an epizootic among the tarbagans in Y. in 1953.). The boy lived in the tent of a hunter, helping him in dressing out the carcasses of dead tarbagans. On 28-29 August, he noticed a red itching spot on his right shoulder. This quickly vanished. At the same time, a pain started in the same arm, in the axillary region, and a growing swelling appeared. Then came chills and a headache and the temperature rose. On the morning of 3 September, a heavy pain appeared in the chest and there was coughing and sputum with an admixture of blood. The patient's condition worsened rapidly and the detachment found the patient in an extremely grave condition.

The treatment that was begun had no effect and the boy died 6 hours after the arrival of the detachment.

An autopsy of the body gave the following pathologic-anatomy picture. The body of a boy who had suffered a decreased diet. No external damages are visible. The oral and nasal cavities are filled with a sanguinolent fluid.

There is considerable edema of the tissues of the left shoulder and rib cage; the tissues are saturated with a hemorrhagic fluid. The axillary bubo

is adherent to the surrounding tissues and is the size of a huge walnut. In cross section, the bubo is juicy and hyperemic, with hemorrhages in the tissue. The vessels of the subcutaneous cellular tissue are injected. There is a small amount of hemorrhagic fluid in the pleural cavity. The lungs are enlarged, hyperemic, and a frothy fluid flows from the surface of the incision. The myocardium is a grayish color and flaccid. There are punctate hemorrhages on the pericardium and also in the heart muscles.

The spleen is acutely enlarged, the capsule turgid, a dark cherry color in cross section, with a large scraping of pulp. The liver is enlarged, with sections of an orangeish yellow color. The pathologic-anatomy findings also confirmed the diagnosis of bubonic plague complicated by a secondary plague pneumonia. The final diagnosis was confirmed by bacterioscopic, bacteriological and biological methods.

It is of interest that a sputum culture, taken from the boy prior to beginning the therapy, gave a profuse growth of the plague microbe. A live test animal that was inoculated with the sputum died on the 3rd day with a characteristic pathologic-anatomy picture of plague and an isolation of a pure culture of the plague microbe. The cultures from the organs of this boy's body gave a significantly smaller growth. A live test animal that was inoculated with an emulsion made from the parenchymatous organs died only on the 8th day. Evidently, the therapy that had been started, chiefly with streptomycin, had exerted an antibacterial effect that had sharply decreased the number of plague microbes.

Nidus No. 5. On 12 September, the detachment answered a call to a 12 year old boy who had taken ill 48 hours prior.

The patient complained of a violent headache and a sharp pain in the left arm, which he held in a constrained position, not allowing it to be touched. In an examination of the patient, we detected a red excited face, acutely injected sclera of the eyes and a temperature of 39.5°C. No visible injuries (scratches, fresh cuts, abscesses) were found during the examination of the hand and forearm.

In the region of the elbow joint, there was an edema of the tissues and a painful lymph node that was adherent to the surrounding tissues and enlarged to the dimensions of a kidney bean. In the axillary region, we detected a lymph node that was enlarged to the size of a walnut and adherent to the adjacent skin tissues. There was considerable edema of the tissues, which extended over to the rib cage and shoulder. A small amount of hemorrhagic fluid was obtained by a puncture of the axillary lymph node.

We immediately started treating the boy with streptomycin, sulfidine and cardiac stimulants; antiplague serum was not used..

The following was learned in the epidemiological investigation: three days prior to the illness, the boy had been cleaning a tarbagan that a dog had brought to the tent. (Plague epizootics among rodents have been registered for many years in the place where this family's camp was located.). The illness

began acutely, with chills, rise in temperature and headache. The sharp pain and tumescence in the region of the elbow joint appeared almost simultaneously.

Typical gram-negative bipolar bacilli were detected in an examination of the smear made from the puncture of the given bubo. The culture of the puncture was negative for plague. In spite of this, based on the epidemiological and clinical findings, and also on the strength of the positive bacterioscopy, we diagnosed the illness as bubonic plague.

After therapy, the boy was released in good condition.

It is seen from the cited data that of the 5 persons that were infected with primary plague, the infection had occurred in 2 via the alimentary tract, from the consumption of the improperly cooked meat of diseased tarbagans, which was followed by the development of intestinal plague (the 4 year old child and the 18 year old youth). The changes detected in their intestines during autopsy also indicate a primary intestinal infection (the edema; the hyperemia of the intestinal mucosa; the acute enlargement of the mesenteric lymph nodes, which was observed in none of the other cases, where there were different infectional processes).

In two of the first cases, the infection had evidently occurred from the bites of fleas. As a result, there was one case of bubonic plague (the 12 year old boy) and one of cutaneous bubonic plague (the 40 year old man). The itching red spots on the skin, which were noted in both cases by the patients themselves, indicate an infection by flea bites.

In one case, the primary infection probably occurred from an insignificant injury to the skin of the hand during the dressing of a dead tarbagan that had been brought to the tent by a dog. This resulted in a case of bubonic plague.

#### Conclusions

1. In our work, we found the method of collecting deceased rodents as the most effective in an epizootological examination of a territory and in determining the extent of an epizootic.
2. In spite of the great variety of rodents, only the tarbagans were involved in the epizootic.
3. There were 9 human illnesses, involving different clinical forms of plague, in 5 independently developed nidi of plague.
4. We observed primary intestinal forms of plague in 2 of the nidi. The diagnosis was made on the basis of clinical, epidemiological, pathologic-anatomical and bacteriological findings.
5. Of 5 persons who initially became ill with different clinical forms of plague, four were found to have a secondary plague pneumonia that developed independently from the primary form of the disease.

6. The fact of the frequent occurrence of a secondary plague pneumonia requires future study of the properties of both the microorganism (the plague pathogen) and, particularly, of the macroorganism - the native population of the cited nidus.

7. Timely treatment with streptomycin, sulfidine, and other agents, without the use of antiplague serum, enabled us to cure 4 patients, including 3 cases of the primary pneumonic form of plague (from the number of first contacts) and one case of the bubonic form.

8. The prophylactic plague vaccination that is being conducted almost yearly among the population of the subject aymak (with EV vaccine) did not protect against the disease in the cited cases, as practically all of those who became ill had been immunized in May, 1953.